

AUTOMATED INTERPRETATION OF CODES

Field of the invention

5 The present invention relates to interpreting codes, such as legal or other codified provisions.

Background

10 The term code, and codified provisions, is used herein to refer to any set of formalized statements of conduct of individuals or legal entities, such as corporations. Such codes may be laws, such as those of civil or criminal justice, international laws, policy statements, contract provisions, agreements, regulations, rules of association, constitutions, codes of conduct, and so on.

15 Different parties are affected differently by the way in which codes are framed, or used in the context of debate, arbitration, and so on. Such parties are typically interested in what provisions of the code (for example, sections of the law) are applicable to the different parties.

20 Information technologies are currently used to store and access codes in their many manifestations. Many organisations store laws in databases, and provide a query interface to search or browse the stored legal provisions. Such searches are typically based upon keywords, and are not tailored to an individual user's needs. As an example, the results of
25 a given search are the same irrespective of whether the user is a lawmaker, citizen or policy adviser. Interpretation and analysis of codes is essentially left to human reason alone.

30 A need exists for an improved manner of using codes in view of these and other observations.

Summary

Codes, such as legal or other codified provisions are represented as logical expressions in a particular rules system. Conversion of the codified provisions to a suitable rules system can be achieved manually, or through suitable automation. The interests of different parties affected by or having an interest in the codified provisions is represented by logical conditions or evaluation expressions that relate to the party's utility. For events that relate to the codified provisions, such as possible or actual violations of the code, the rules are evaluated in view of the event, and each of the party's evaluation expressions.

The logical structure of a code is used to provide a more meaningful manner of using the code. Automatically identifying applicable provisions of a code can be achieved with reference to an individual stakeholder's perspective. At a macro level, national legislatures and legal policy groups can use techniques described herein to analyse the impact of new policing initiatives in their legal system, or detect existing loopholes. At a micro level, such techniques can assist in performing activities such as analyzing the terms of agreement of a software package before agreeing to such terms by proceeding with its installation.

Description of drawings

Fig. 1 is a schematic representation of the architecture and operation of a system for interpreting codes as described herein.

Fig. 2 is a flow chart of the steps involved in interpreting legal codes as described herein.

Fig. 3 is a schematic representation of a computer system suitable for performing the techniques described herein.

Detailed description

The automated interpretation of code is described in further detail, and specific examples are described relating to the interpretation of a legal code, and a corporate travel policy.

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Not all parties who are stakeholders in a code are equally conversant with all aspects of its detailed provisions. But such parties are often expected to take timely actions based on a good understanding of the provisions. As an example, when an apparent crime occurs, police officers are obliged to file an initial report, which is used as the basis for further investigation. Errors in procedure may be used by the legal defence team for the accused to exempt the accused from prosecution.

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Different stakeholders can be assisted in interpreting the provisions of a code with respect to those stakeholder's utility perspective. In the above example of a criminal prosecution based upon a legal code, such stakeholders and their respective utility perspectives may be, for example, as outlined below.

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- (i) Police – not making technical mistakes in legal procedure
- (ii) Prosecutor – preparing the prosecution case for successful prosecution
- 20 (iii) Defense – preparing defence case for acquittal, or minimum sentencing
- (iv) Lawmakers – detecting loopholes

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Fig. 1 schematically represents a general system architecture **110** for interpreting codes. Code **130** is mapped to target rules **140**, the output of which is provided as input to a rule evaluation engine **150**. The rule evaluation engine **150** also has as inputs a user perspective **110**, and a triggering event **120**. The rule evaluation engine **150** provides as output applicable provisions **160** of the code **130**.

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Fig. 2 presents a flow chart **200** of steps performed by the system architecture **100** of **Fig. 1**. A target rule technology is selected in step **210**. A code-to-rule transformation is then selected in step **220**. Finally, the transformed rules are evaluated in the presence of events in step **230**. Various forms of implementation are possible for the system and procedure outlined in **Figs. 1** and **2**, depending upon application requirements.

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The code 130 is represented as a set of rules. Given the rules 140 and, optionally, an event trigger 120, such as a reported crime, the rules 140 are applied and evaluated assuming a particular user perspective 110. This user perspective 110 is represented as an evaluation
5 function, which evaluates the target rules 140. The steps outlined in Fig. 2 are now described in further detail.

Selecting a target rule technology – step 210

10 At the outset, a decision is made on the representation of code using rules, namely what rules system is to be used. Examples of available choices for rules systems include fuzzy rules, if-then-else rules, and declarative rules, such as those used in the Prolog computer programming language.

15 A rules system can be selected based upon performance considerations. Rules systems can have particular usage requirements, such as acceptable response time, suitable levels of abstraction, performance of available computing hardware, and overall cost. Rules systems are studied as a discipline in the field of computer science, and the different forms of rules systems are characterized by their processing complexity. A rule can be
20 considered to be a declarative statement in a formal notation.

Scripting rules include assertion (assignment) rules, if-then-else rules, for-loop rules, while-do, do-while, and do-until iteration rules, and can be processed using most programming languages. Inference rules include if-then rules, when-do pattern match
25 rules, and predicate logic rules, which need an appropriate inference engine to process. While scripting rules can be processed a finite time, based on the size and nature of rules, inference on predicate logic rules can be undecidable. That is, the processing time may be unbounded. Accordingly, codes are desirably represented in an appropriate form, such that the rules are amenable to the kind of analysis that is to be performed.

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Selecting a code-to-rule transformation technology – step 220

Code 130 is mapped to a representation in the selected rules system in step 210. Mapping the code 130 to the target rules 140 need not be a literal or exact mapping, but can be any appropriate representation of the code 130. Elegant variations might be adopted for a number of reasons, depending upon the code 130, and the way in which its interpretation is likely to be conducted.

There are many alternatives to transform the code 130 into rules 140. Transformation can be manually performed by those who understand both the code 130 and the selected rules system. The logical structure of the code 130 is mapped, usually from a natural language such as the English language, to the target rules 140 system using the grammar and syntax of the selected rules system. The target rules 140 can be checked to ensure a lack of inconsistency with the code 130.

As an alternative to manually mapping the code 130 to target rules 140, suitable automated methods can be used for whole or part of this task. A template of target rules 140 may be generated automatically, and text or terms extracted from the code 130 used to populate the templates for a “first draft” of the target rules 140. As an example, consider two types of rules system templates in Table 1 below. The first type of rules system of Table 1 below is of the inference rule type, while the second type of rules system is of the scripting rule type.

TABLE 1

WHEN <pattern>

DO <action>

IF <antecedent condition>

THEN <consequent action>

Now consider an code in a corporate business policy: “*When an employee wants to travel on business trip, the approvals of her manager, second-line manager and finance is to be taken prior to any travel arrangements being made*”.

Algorithms used in the field of Natural Language Understanding (NLU) can automatically extract phrases from text such as this provision of a corporate travel policy. **Table 2** below presents a pseudocode algorithm that outlines how automatic mapping of code 130 to target rules 140 can be performed for the case of when-do rules. Essentially, parameters of the rules system templates of **Table 1** above are extracted using the algorithm of **Table 2** below, and these extracted components are used to populate the rules system templates.

TABLE 2

Algorithm: CodeToWhenDoRuleMapper (Code_text)

The text to be extracted is <pattern(s)> and <action(s)>

Let Extracter1 = An NLU algorithm trained to extract <pattern(s)>

Let Extracter2 = An NLU algorithm trained to extract <action(s)>

1. <pattern> = Extractor1(Code_text)
2. <action> = Extractor2(Code_text)
3. NewRule = Create and populate when-do rule instance with <pattern> and <action>
4. Return NewRule

When CodeToWhenDoRuleMapper() algorithm in **Table 2** above is invoked on the example policy text, the parameter <pattern> may be “business trip” and the parameter <action> may be “approval of manager; approval of second-line manager; approval of finance”. The returned rule is presented in **Table 3** below.

TABLE 3

WHEN (“business trip”)

DO get-approval (“approval of manager”),

get-approval (“second-line manager”),

get-approval (“and finance”).

Evaluating rules in the presence of events – step 230

The target rules **140** can be analyzed using an appropriate rule evaluation function. The
5 target rules **140** may be evaluated in response to a triggering event **120**, and in view of a
particular user perspective **110**. Optionally, the information relating to an event (for
example, a crime) may make some rather than all the rules applicable for analysis. The
user perspective **110** reflects a particular user's interest in the code **130**, with which the
rule evaluation function is consistent.

10 Some examples of evaluation functions are presented in **Table 4** below. Such evaluation
functions may be used by various interested parties, such as teams prosecuting or
defending a person alleged to have violated the code **130**. Various other examples are
possible, and vary according to the context of the code **130** under consideration, and its
15 use.

TABLE 4

- | | | |
|----|---|--|
| • | Max R_i | The number of applicable codes are maximum |
| • | Max PR_i | The punishment in the applicable codes are maximum |
| 20 | • | Min R_i The number of applicable codes are minimum |
| • | Min PR_i | The punishment in the applicable codes are minimum |
| • | For any event E , $R_i \neq \text{empty}$ | The codes are defined for every crime |
| • | For any event E , $PR_i \neq 0$ | No crime goes unpunished |
-

25 The result of using an evaluation function of the type tabulated in **Table 4** above depends
upon the target rules **140** that are used to represent the code **130**, and the evaluation
function that is used to evaluate the target rules **140**.

30 ***Computer hardware***

Fig. 3 is a schematic representation of a computer system **300** of a type that can be used, with suitable software, to interpret codes **130** as described herein. Computer software executes under a suitable operating system installed on the computer system **300** to assist in interpreting codes **130** as described. This computer software is programmed using any
5 suitable computer programming language, and may be thought of as comprising various software code means for achieving particular steps.

The components of the computer system **300** include a computer **320**, a keyboard **310** and mouse **315**, and a video display **390**. The computer **320** includes a processor **340**, a
10 memory **350**, input/output (I/O) interfaces **360**, **365**, a video interface **345**, and a storage device **355**.

The processor **340** is a central processing unit (CPU) that executes the operating system and the computer software executing under the operating system. The memory **350**
15 includes random access memory (RAM) and read-only memory (ROM), and is used under direction of the processor **340**.

The video interface **345** is connected to video display **390** and provides video signals for display on the video display **390**. User input to operate the computer **320** is provided from
20 the keyboard **310** and mouse **315**. The storage device **355** can include a disk drive or any other suitable storage medium.

Each of the components of the computer **320** is connected to an internal bus **330** that includes data, address, and control buses, to allow components of the computer **320** to
25 communicate with each other via the bus **330**.

The computer system **300** can be connected to one or more other similar computers via a input/output (I/O) interface **365** using a communication channel **385** to a network, represented as the Internet **380**.
30

The computer software may be recorded on a portable storage medium, in which case, the computer software program is accessed by the computer system **300** from the storage device **355**. Alternatively, the computer software can be accessed directly from the

Internet 380 by the computer 320. In either case, a user can interact with the computer system 300 using the keyboard 310 and mouse 315 to operate the programmed computer software executing on the computer 320.

- 5 Other configurations or types of computer systems can be equally well used to interpret legal codes as described. The computer system 300 described above is described only as an example of a particular type of system suitable for implementing the described techniques. As an example, suitable software may instead be implemented using a personal digital assistant (PDA) or other similar computing device.

10

Computer software

- As described, the same code is interpreted for different users, and one can thus expect that such users may prefer to use different types of devices. Software that executes on
15 particular hardware may be subject to hardware-related restrictions that can limit the software features that are available using that hardware. As an example, personal digit assistants (PDAs) have memory ranging in capacity from hundreds of kilobytes to a few Megabytes. Desktop personal computers have memories ranging in capacity from hundreds of Megabytes to a few Gigabytes, while high-performance servers can have a
20 memory capacity in the range of hundreds of Gigabytes.

- Since code 130 represented as rules 140 is loaded into memory for interpretation, not all hardware can process with the same set of rules 140. Either the number of rules can be reduced for smaller devices, or the level of detail reduced. The former is not an option as
25 the soundness of interpretation may be affected. Accordingly, more complex rules 140 may be limited to correspondingly sophisticated computing hardware.

Example - Indian Penal Code

- 30 As a particular example, consider the Indian Penal Code system (IPC) as a code 130. Sections 299 to 309 of the IPC apply to the suspicious death of a person. Possible reasons range from suspected homicide, murder, suicide, etc, as indicated in **Table 5** below.

TABLE 5

| | |
|------|--|
| 299. | Culpable homicide |
| 300. | Murder |
| 301. | Culpable homicide by causing death of person other than person whose death was intended |
| 302. | Punishment for murder |
| 303. | Punishment for murder by life-convict |
| 304. | Punishment for culpable homicide not amounting to murder |
| | 304A. Causing death by negligence |
| | 304B. Dowry death |
| 305. | Abetment of suicide of child or insane person |
| 306. | Abetment of suicide |
| 307. | Attempt to murder |
| 308. | Attempt to commit culpable homicide |
| 309. | Attempt to commit suicide |

Stage 1: Identify code

This example concerns only a particular aspect of the IPC, namely those sections of the IPC relating to death. The relevant sections are a subset of those presented in **Table 5** above, namely Sections 299 to 304. These Sections are provided in **Table 6** below.

TABLE 6

| | |
|------|-------------------|
| 299. | Culpable homicide |
|------|-------------------|

Whoever causes death by doing an act with the intention of causing death, or with the intention of causing such bodily injury as is likely to cause death, or with the knowledge that he is likely by such act to cause death, commits the
5 offence of culpable homicide.

300. Murder

Except in the cases hereinafter excepted, culpable homicide is murder, if the act
10 by which the death is caused is done with the intention of causing death, or

Secondly, if it is done with the intention of causing such bodily injury as the offender knows to be likely to cause the death of the person to whom the harm is caused, or
15

Thirdly, if it is done with the intention of causing bodily injury to any person and the bodily injury intended to be inflicted is sufficient in the ordinary course of nature to cause death, or

20 Fourthly, if the person committing the act knows that it is so imminently dangerous that it must, in all probability, cause death or such bodily injury as is likely to cause death, and commits such act without any excuse for incurring the risk of causing death or such injury as aforesaid.

25 301. Culpable homicide by causing death of person other than person whose death was intended

If a person, by doing anything which he intends or knows to be likely to cause death, commits culpable homicide by causing the death of any person, whose
30 death he neither intends nor knows himself to be likely to cause, the culpable homicide committed by the offender is of the description of which it would have been if he had caused the death of the person whose death he intended or knew himself to be likely to cause.

302. Punishment for murder

5 Whoever commits murder shall be punished with death, or imprisonment for life,
and shall also be liable to fine.

303. Punishment for murder by life-convict

10 Whoever, being under sentence of imprisonment for life, commits murder, shall
be punished with death.

304. Punishment for culpable homicide not amounting to murder

15 Whoever commits culpable homicide not amounting to murder shall be punished
with imprisonment for life, or imprisonment of either description for a term
which may extend to ten years, and shall also be liable to fine, if the act by which
the death is caused is done with the intention of causing death, or of causing such
bodily injury as is likely to cause death,

20 or with imprisonment of either description for a term which may extend to ten
years, or with fine, or with both, if the act is done with the knowledge that it is
likely to cause death, but without any intention to cause death, or to cause such
bodily injury as is likely to cause death.

25 304A. Causing death by negligence

 Whoever causes the death of any person by doing any rash or negligent act not
amounting to culpable homicide, shall be punished with imprisonment of either
description for a term which may extend to two years, or with fine, or with both.

30

304B. Dowry death

(1) Where the death of a woman is caused by any burns or bodily injury or occurs otherwise than under normal circumstances within seven years of her marriage and it is shown that soon before her death she was subjected to cruelty or harassment by her husband or any relative of her husband for, or in connection with, any demand for dowry, such death shall be called “dowry death”, and such husband or relative shall be deemed to have caused her death.

Explanation: For the purpose of this sub-section, “dowry” shall have the same meaning. as in Section 2 of the Dowry Prohibition Act, 1961 (28 of 1961).

(2) Whoever commits dowry death shall be punished with imprisonment for a term which shall not be less than seven years but which may extend to imprisonment for life.

15

Stage 2: Identify target rules

The use “if-then” rules is assumed in this case. **Tables 7, 8 and 9** below present, as examples, target rules **140** for respective Sections 299, 300 and 301 of the IPC. **Table 7** below presents target rules **140** for Section 299 of the IPC dealing with “Culpable homicide”.

TABLE 7

IF

Event == death and

Intention == cause_death

THEN

Offence = culpable_homicide and

IPC_applied.update(299)

The target rules 140 of Table 7 has the statement `IPC_applied.update(299)`. “IPC_applied” is a set referring to the set of IPC provisions that are applicable. The `update()` function adds a new element to this set. Hence, in this example, `IPC_applied = {299}`. A corresponding statement is `IPC_applied = IPC_applied ∪ {299}`, in which ∪ is the union set operator.

Section 299 of the IPC permits “*intention to be enough harm that it causes death*”. This provision is complex to represent in the “if-then” rules system and, incidentally, is difficult to determine from a preliminary investigation of a suspected violation of this Section. Hence, the target rules 140 may disregard this aspect of the code 130 without detrimental effect to the practical use of interpreting the code 130.

Table 8 below presents target rules 140 for Section 300 of the IPC dealing with “Murder”.

15

TABLE 8

```
IF
    Offence == culpable_homicide and
    IPC_applied not in [301 to 309]
THEN
    Offence = murder and
    IPC_applied.update(300)
```

Table 9 below presents part of the target rules 140 for Section 301 of the IPC dealing with “Culpable homicide by causing death of person other than person whose death was intended”.

30

TABLE 9

```
IF
    Offence == culpable_homicide and
    intended_person = dead_person
```

THEN

Offence = culpable_homicide and
IPC_applied.update(301)

5 ...

Stage 3 and 4: Evaluate rules

10 Suppose the event is the death of a male person and there is a repentant accused present. A first case recording the crime, which requires a detailed analysis of all relevant legal provisions. Accordingly, an evaluation function of “Max R_i ” can be used, which implies that no IPC provision should be missed.

15 **Table 10** below presents a pseudocode function of how evaluation is performed. The **RULE_list** for this example is the set of IPCs represented as rules.

TABLE 10

20 **Function Evaluate(RULE_list, EvalFunction, event) {**
 1. Result = {}
 2. For each RULE_item in RULE_list
 3. If(EvalFunction(RULE_item, event) == Success) {
 a. Result = Result U RULE_item
25 }
 }
}

Max $R_i()$, the evaluation function in the example, can be implemented as follows:

30 **Function Max R_i (Rule_item){**
 1. If Rule_item relates to event

```
        a. Return SUCCESS
    2. Else
        a. Return FAILURE
}
```

5

From the set of IPC presented in **Table 6** above (Sections 299 to 304), Sections 299 and 300 are returned as applicable when the target rules **140** are evaluated using this rule evaluation function. Section 301 is not applicable, as the accused is claiming that he perpetrated the crime. Section 302 is applicable as the possible section for punishment. Section 303 is not applicable the accused is not a life-convict, as the accused is not in jail. Section 304 is not applicable as the accused is not involved in a road driving case or dowry case.

15 A second case is defence of the accused, which concerns minimizing punishment of the accused. Accordingly, the evaluation function adopted in this case might be “Min PR_i ”, which reflects this objective of minimizing punishment of the accused.

From the set of IPC presented (Sections 299 to 304), the Section 304A has the minimum punishment. Therefore, the defense may want to downgrade the event as a traffic accident or careless driving.

Example – corporate travel policy

25 *Stage 1: Identify code*

The code **130** in this example is a corporate travel policy concerning how business travel is to be conducted. **Table 11** below outlines Articles of this travel policy.

30

TABLE 11

1. Planned Business Travel

The trip is planned not less than 2 weeks in advance from the date of commencement. The approval of the immediate manager is required. Economy class travel using company approved transport and hotel vendors must be used for making reservations.

2. Immediate Business Travel

The trip is planned not less than 2 days in advance from the date of commencement. The approval of the second-line manager is required. Company approved hotel vendors must be used for making reservations and a justification for the immediateness of the travel has to be submitted.

3. Urgent Business Travel

The trip needs to start immediately. The approval of the CFO is needed and a justification for the urgency of the travel from the employee's manager has to be submitted.

Stage 2: Identify target rules

As with the former rules, the use of if-then rules is assumed. **Tables 12, 13 and 14** present target rules **140** for respective Articles of the travel policy. **Table 12** below presents target rules **140** for Article 1 of the travel policy entitled "Planned Business Travel".

TABLE 12

IF
 Travel_notice >= **2_weeks** and
 Approval = **1st_manager**
THEN
 Travel_type = **planned** and

Travel_vendor = company_approved and
Hotel_vendor = company_approved

5 Table 13 below presents target rules 140 for Article 2 of the travel policy entitled
“Immediate Business Travel”.

TABLE 13

IF
10 Travel_notice >= 2_days and < 2_weeks and
Justification = true and
Approval = 2nd_manager
THEN
Travel_type = immediate and
15 Hotel_vendor = company_approved

Table 14 below presents target rules 140 for Article 3 of the travel policy entitled “Urgent
Business Travel”.

20

TABLE 14

IF
Travel_notice < 1_day and
Justification = true and
25 Approval = CFO
THEN
Travel_type = urgent

30 *Stage 3 and 4: Evaluate rules*

The example may be one in which an employee is asked to travel for business, and needs to know which of the relevant provisions of the travel policy are applicable. This example thus may have an evaluation rule of “Find R_i ”. This evaluation rule finds the relevant Articles of the travel policy. Another evaluation function can be Find R_i (Min Company_Approved_Vendor), which finds Articles with maximum freedom concerning which vendor can be selected. The mechanics of this operation are similar to that described in the above example in relation to the IPC, and are accordingly not repeated for this example.

The evaluation function and the event are used to determine the resulting rule list. From the three Articles, the Article which results from the evaluation function is “Immediate Business Travel”, which indicates that the employee should seek approval from his second line manager. This Article also indicates that the employee should also use a company approved hotel, but can book on any flight.

Another example is that of a team evaluating corporate travel policies. The team wants to know which employee groups are not covered by the travel policy. The evaluation function that can be used in this case is “Find Emp_i (Find $R_i = 0$)”. This evaluation rule finds employees for whom no travel policy rule is currently specified.

As a result of this evaluation, one can determine that, assuming that there are employees above the Chief Financial Officer (CFO) of the company (for example, Chief Executive Officer (CEO)), all employees with grade above CFO cannot make urgent business travel because those employees cannot seek approval from a lower ranked officer. Hence, the Urgent Travel rule may be modified accordingly to clarify any ambiguity or address any limitation of the travel policy.

Conclusion

Various alterations and modifications can be made to the techniques and arrangements described herein, as would be apparent to one skilled in the relevant art.